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ABSTRACT

Computer assisted instruction (CAI) provides active and non-linear instruction, but the microcomputer-videotape combination permits development of a broader range of instructional activities not previously possible with microcomputers alone. Instructional materials can be displayed alternately from the microcomputer or the videocassette recorder-player, depending on instructional program design needs. Moving and colorful visual materials, actual pictures, spoken descriptions, instructions, and music can now be added to CAI. The integration of the computer and the video player offers the advantages of incorporating actual lectures, demonstrations, and experiments into the CAI lessons; using the same, though modified, database to utilize different learning strategies for individual students; and grouping students conveniently to review or repeat lessons or presentations. Furthermore, computer programs and videotapes are easier to revise, update, or modify than videodisc programs. Because of these advantages, several institutions and organizations are applying interactive video in courseware development, including Florida A and M University, where a project has been implemented to develop and evaluate instructional materials for science and mathematics which utilize interactive video systems. This report includes flowcharts illustrating two types of instructional strategies incorporating CAI with videotape and nine references. (LMM)

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INTEGRATING CAI AND VIDEOTAPE FOR SCIENCE AND MATHEMATICS TEACHING

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INTEGRATING CAI AND VIDEOTAPE FOR SCIENCE AND MATHEMATICS TEACHING

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The role and significance of science and technology in today's society is becoming increasingly vital to this nation's progress. In business, industry, government and in a multitude of professions and occupations and even in those areas where its impact has never been felt before, scientific and technical literacy is becoming an essential element to success.

Yet, more students than ever before are avoiding science and mathematics courses after the tenth grade and are effectively eliminating the possibility of a science or engineering career at the age of sixteen. Moreover, the National Assessment of Science, 1966-67, published that there is continued decline in science knowledge which was most dramatically noted in the physical sciences.

In a report to the President of the United States, the National Science Foundation and the Department of Education indicated that the country is facing a shortage of trained personnel in engineering, computer sciences and selected areas in the physical and life sciences (Hufstedler and Langerberg, 1981). On two separate occasions before the Southern Regional Education Board (June, 1981) and the Education Commission of the States (August, 1981), Florida Governor Bob Graham described the situation as a "disaster", and is approaching the point of becoming a threat to the national security.

In a survey conducted by the National Science Teachers Association (1982) of 600 teacher placement offices, results showed there was a 64% decline in the number of science teachers produced by U.S. colleges and

universities. Chemistry and physics were the hardest hit. The supply of science majors is insufficient to meet the demand for full-time science teachers and the shortage is predicted to become more acute in this decade. Of those newly employed science and math teachers in 1981, an average of 50.2% were unqualified in these areas. Therefore, if the nation's youth have to be adequately prepared for today's scientific and technological demands, teacher support systems applying new computer technologies seem to be in order.

Addressing this problem is a joint project by the College of Arts and Sciences and the Laboratory School of Florida A&M University with the primary objective to develop and evaluate instructional materials in science and mathematics utilizing interactive video.

The Capabilities of Interactive Video

Ignatz(1982) reported that students found invaluable, non-threatening and effective instructors in the microcomputer. Microcomputer technology is interactive in delivery. Where other instructional aids are passive and linear in format, computer-assisted instruction provides active and non-linear instruction. Branching allows an instructional program to be tailored according to the levels of mastery of individual students. Students can proceed at their own rate of learning; thus, students are on task at all times.

The graphics capabilities of the microcomputer combined with the use of shape tables have the immense potential for simulating science concepts. Very recently, three-dimensional plotting has been added to the two-dimensional graphics capabilities. Movement can be produced by

means of shape tables that appear at a certain screen location, disappear and then reappear at a proximate position, disappear, etc. in this spatial order at split second intervals until the shape arrives at its destination. The paddles and pushbuttons are equipped with a potentiometer so that they can be used to identify objects or print on the screen in the same manner the cathode ray tube was utilized in CAI lessons in recent years. They can also be utilized by the student to plot points in graphing.

By integrating videotapes with microcomputer instructions, moving, colorful and visual materials, actual demonstrations and spoken descriptions, and music can be added to the character of computer-assisted instruction. Other modes of presentation possible with the computer-assisted video-recorded instruction are: (1) computer display and sound from the videotape, (2) branching forward or backward to frames within the videotape, (3) frozen-frame video display while the videoplayer is on pause, and (4) replay of a previous section of video (Schwartz, 1980).

The integration of the computer and the videoplayer offers several advantages including the following:

1. Videotapes of actual lectures, demonstrations, directions, explanations, experiments by teachers, lectures and university or college faculty may be incorporated into CAI lessons;

2. With appropriate branching instructions, the instructional materials with the same data base can be modified to utilize different learning strategies while presenting materials to students with different levels of achievement;

3. The teacher can conveniently group students without having to repeat lessons and explanations to each group;

4. Groups of students can interact with the video-CAI program whenever they need to go over the material for review or notetaking;

5. Students can study difficult presentations repeatedly;

6. The same programs may be used by different classes for a number of years;

7. Tapes and computer programs are easy to edit and revise; thus, they can be updated more quickly and easily than a textbook and teachers can adapt them to their teaching styles or preferences; and

8. They are cost-effective.

The Videodisc vs. the Videotape

Several institutions and organizations are applying interactive video in courseware development. Some courseware developers prefer the videotape; and others, the videodisc. Videodisc production has a few advantages over the videotape including clear single frame display, faster access time (less than 2 seconds), reverse motion, two separate audio channels and durability.

However, videodisc production is very costly in comparison with the videotape. Videodisc mastering is also very time-consuming; it could run from four to six weeks. Most users who prefer the videotape over the videodisc indicate that canned-off-the-shelf packages hardly meet their objectives and videotapes are easier to upgrade as new procedures are developed or to revise according to user preferences. Access time for videotapes generally require less than 10 seconds in a carefully planned interactive video lesson such as where video material is presented in sequential segments. It might take as long as 3 minutes to search for a videotape segment from the beginning to a frame that is close to the end of a tape but while the search is taking place CAI may be displayed on the screen.

At Florida A&M Unviersity, the site of the program development, videotapes are being produced. Inasmuch as videodiscs are initially developed from videotapes, considerations for the production of videodiscs

from the final videotapes will be made at the final dissemination stage of the project.

Nature of the Interactive Video Instructional Materials

CAI Programs

Simulations of experiments being developed address concept formation and reasoning with the utilization of variable manipulations, gathering of data, graphing and interpretation of data. Simulations are as close to real life as possible. Color and movement emphasize the salient features in the simulations.

Problem solving capitalizes on a strategy including: (1) classifying the problem by type according to problem characteristics, i.e., symbols, diagrams, relevant formulas, and arithmetic operations, (2) identifying the unknown, (3) identifying the data, and the relationship between them, (4) constructing a representation of the situation, (5) identifying the conditions, if any, (6) carrying out the solution steps, and (7) checking the result. The program also includes prompts to assist the student in recognizing the inconsistency of an answer and to search systematically for the source of error.

Interpretation of charts, tables, plotting and graphing are done on the high resolution graphics screen with the use of the paddles and pushbuttons.

Videotape Programs

A videotape material is applied when (1) it enhances the concept; (2) it plays a role in defining the concept, and (3) instruction is delivered more efficiently by the videotape than by any other medium.

Guidelines in the development of a videotape material consists of the following:

1. It must be brief;
2. It must be limited to the essential elements of the concept;
3. All instructional aids and science materials must be prepared beforehand with the exception only of that which will be the focal point(s) of the presentation;
4. Laboratory experiments must be limited to proper techniques, notices of any chemical hazards and/or precautions to be taken; and
5. Videotaped demonstrations may be interrupted for question/answer, clarification and/or interpretation of steps in the experimental techniques and data analysis as the need arises.

The flowcharts on the following pages illustrate two types of instructional strategies incorporating CAI with videotape in the project design. These examples illustrate particular strategies selected to deliver the respective lessons. They do not represent a general format of instruction.

The titration program begins with a video demonstration by a faculty member of an actual experiment and the computation of the concentration of the unknown solution followed by a computer simulation enabling a student to titrate a solution of unknown concentration with a standard solution of known concentration and then determine the concentration of the unknown solution.

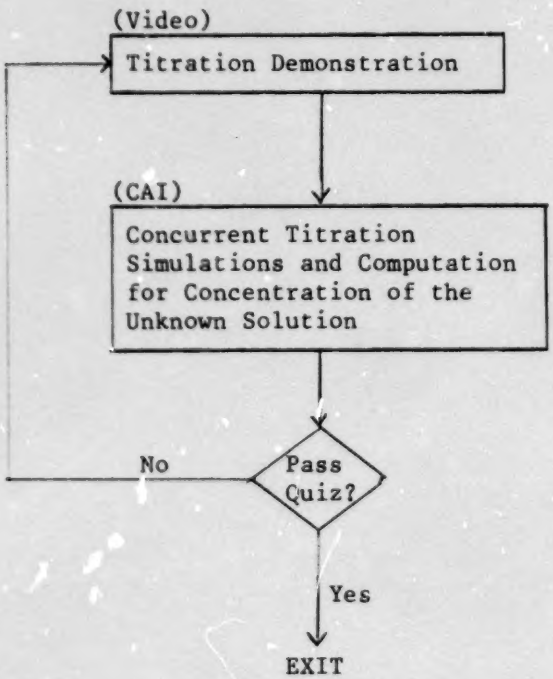
The lessons on the graphing of sinusoids guide the student to discover in 2 steps the four (4) constants in the general equation: $Y = C + A\ TRG\ B(\theta - D)$ where TRG is sin or cos. In the first step, the student assigns values to A and B and the microcomputer draws the graph for the resulting equation: $Y = A\ TRG\ B\theta$. By controlling one

constant at a time, he discovers what A and/or B stand for. In the second step, the values of A and B are held constant while the student manipulates the values of C and D in the general sinusoidal equation until he discovers what the latter stand for. A videotape presentation assists the student only when he fails in discovering the meaning of the constants by himself. In the last 2 stages, the student is guided through the determination of the critical points of a given graph for a sinusoidal equation prior to sketching the graph.

FLOWCHARTS

I. Titration

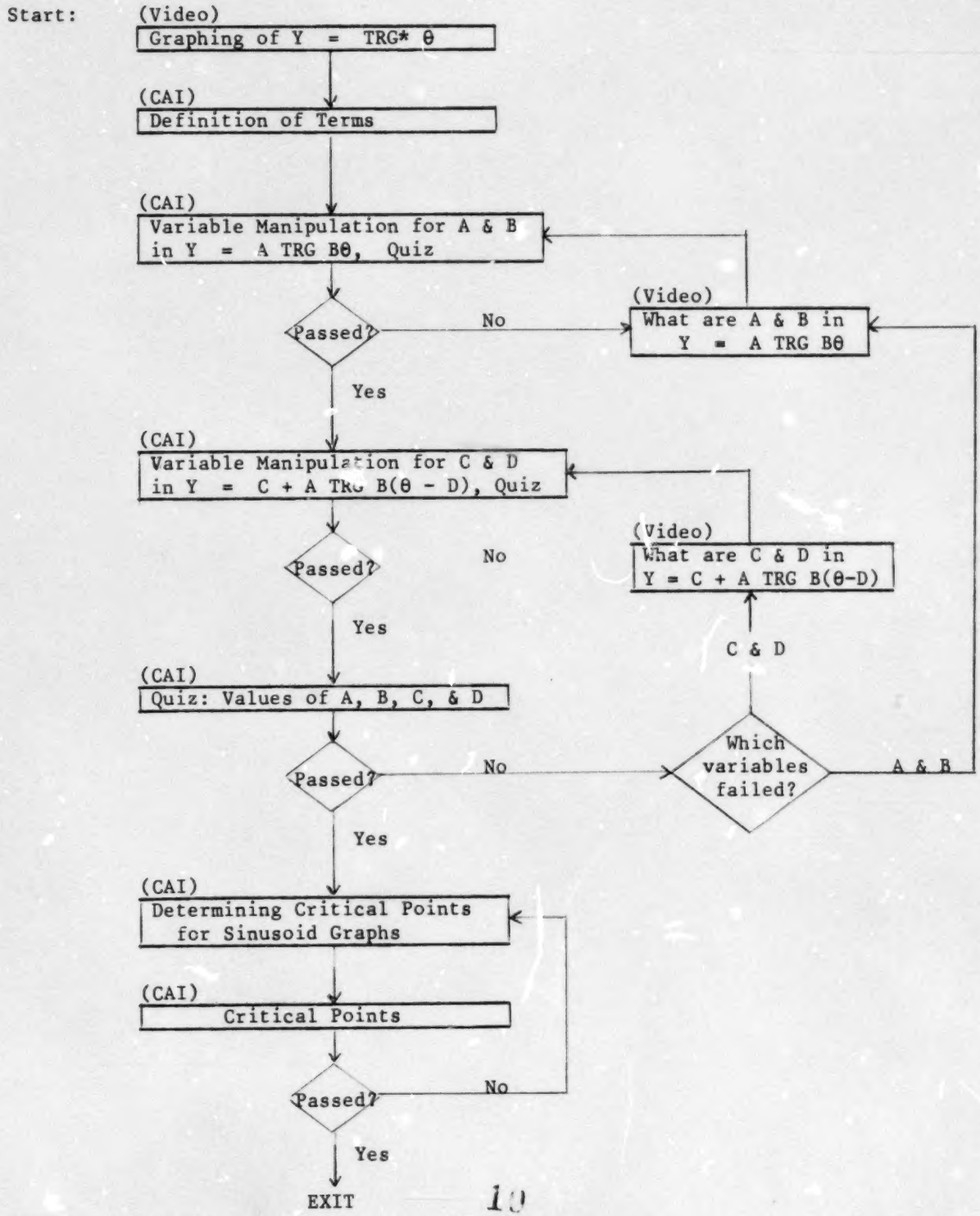
Objective: The student will be able to determine the concentration of an unknown acid or base given the volume and the concentration and volume of the standard solution.



II. Graphing of Sinusoids

Objectives: 1. Given the graph of a trigonometric function, the student will be able to find the equation.

2. Given the equation of a trigonometric function, the student will be able to sketch the graph.



*TRG = sin or cos

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